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ABSTRACT

Creativity was examined in 102 middle and lower class children across a wide age range (7 to 13 years) and intellectual ability (low average to gifted). The instruments were lenient (16 items) and stringent (4 items) solution standard measures of original problem solving, and two subtests of the Wechsler Intelligence Scale for Children. Scores for quantity (popular responses) and for quality (unusual responses) were computed for lenient and stringent measures. Three sets of findings that obtained in all ages, intelligence level, and socioeconomic status groups provided support for the construct validity of the J. Guilford-M. Mednick conceptualization of original thinking. Differences were found as a function of social class but not intelligence. Middle class children generated more quality responses on stringent tasks, and the relationship of quality to quantity was stronger. Stringent tasks were considered better predictors of real world creative behaviors than lenient ones. (Author/CL)

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CREATIVITY AS ORIGINAL PROBLEM-SOLVING IN GIFTED AND NONGIFTED LOWER- AND MIDDLE-CLASS CHILDREN*

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Roberta M. Milgram

Abstract

Creativity was examined in 142 middle- and lower-class children, across a wide range of age (7-13) and intellectual ability (low average to gifted). The instruments were lenient (16 items) and stringent (4 items) solution-standard measures of original problem-solving, and two subtests of the WISC. Scores for quantity (popular responses) and quality (unusual responses) were computed for lenient and stringent measures.

Three sets of findings that obtained in all age, intelligence level, and SES groups provided impressive support for the construct validity of the Guilford - Mednick conceptualization of original thinking. There were two consistent relationships: one between corresponding scores on lenient predictor measures and stringent criterion measures, and one between quantity and quality scores within lenient and stringent tasks. The data also demonstrated a general order effect with popular responses occurring earlier, and unusual responses later, in the response sequence--an order effect that was stronger for high than for low creative children.

Although reinforcement failed to increase original responding, it is premature to conclude that verbal reinforcement is ineffective for this purpose. Differences were found as a function of social class but not intelligence. Middle-class children generated more quality responses on stringent tasks, and the relationship of quality to quantity was stronger. Girls and boys were equal in original problem-solving ability; the reasons why fewer women make outstanding creative contributions than men, therefore, may well be found in the realm of socialization.

Stringent tasks are considered better predictors of real-world creative behaviors than lenient ones. Nevertheless, the investigators cautioned against equating either the predictor or the criterion measures of the current study with creative attainments in the real world.

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Chapter One

INTRODUCTION

Definitions of creativity as a phenomenon are elusive. Creativity is defined here as an intrapersonal and interpersonal process by means of which original, i.e., novel and unusual, products of high quality are developed. The literature on creativity can be classified under the headings product-, person, and process-oriented. The difficulties inherent in developing objective criteria for judging creative products and in assessing the characteristics of creative persons have led many investigators -- as a first step -- to focus on creative cognitive processes.

Numerous great men and women have described the creativity in their own lives in terms of a problem-solving process. Many solutions came to mind in the form of ideas and images (Ghiselin, 1955). Among the many solutions were a few highly original ideas which became the basis for a creative product: an opera, a mathematical theory, an engineering feat, a novel solution to a social problem. These introspective reports have led to the conceptualization of the creative process as original problem-solving with ideational fluency as an essential component in the process (Guilford, 1956, 1967; Mednick, 1962; Wallach & Kogan, 1965).

The theorists cited above contend that (1) the generation of many potential solution leads to the production of a few that are highly original, i.e., statistically unusual and of high quality; and (2) popular ideas emerge earlier, and unusual ideas later, in the response sequence. These investigators and others (Getzels & Jackson, 1962; Torrance, 1974) developed measures of original problem-solving based on ideational fluency. These measures were subsequently used in research to validate the introspective reports of creative people and the theoretical conceptualizations of creativity.

Wallach (1970, 1971) summarized research on ideational fluency measures that demonstrated a strong relationship between the production of a large number of responses and the production of responses that are statistically unusual, but not necessarily of high quality. Milgram, Milgram, Rosenbloom and Rabkin (1978) judged the quality or cleverness of unusual responses in children and adolescents and demonstrated that popular responses and unusual responses of low quality were both associated with the production of responses that qualified as original by being both unusual and of high quality.

These findings were interpreted as providing empirical support for the above-mentioned conceptualizations of original problem-solving and for the validity of measures of ideational fluency. This generalization from ideational fluency predictor measures to original problem-solving in practical life situations is premature, however, because of a basic difference between predictor and criterion measures. In ideational fluency measures, all responses are regarded as solutions to the test problems (except for an occasional bizarre association) because of the lenient standards for what constitutes a solution. In typical life situations, by contrast, problems are more clearly defined, and their solutions have stringent standards. Accordingly, the validity of ideational fluency predictors with lenient solution-standards remains to be demonstrated against external criterion measures with stringent solution-standards.

Research Objectives

In the current research a stringent solution-standard criterion measure of creativity or original problem-solving was developed, and a study was conducted with the following objectives:

(1) To investigate the discriminant validity of lenient and stringent solution-standard measures of original problem-solving with reference to intelligence.

(2) To investigate individual differences in the quality as well as the quantity of responses in these measures as a function of age (7-13), sex, intellectual ability (low average to gifted), and social class (middle- and lower-class).

(3) To investigate the relationship between quantity and quality of response both in lenient and stringent measures.

(4) To investigate the order of appearance of popular and unusual responses in these tasks.

(5) To validate a lenient predictor measure of original problem-solving against a stringent criterion measure.

(6) To investigate the effect of verbal praise on the quantity and quality of original problem-solving in these children.

Chapter Two

RESEARCH METHOD

Subjects

Subjects were 142 middle- and lower-class children in second, fifth, and eighth grades, ranging in intelligence from 85 to 155. The children were divided into six groups based on socioeconomic status[1] and scores of a modified Wechsler Intelligence Scale for Children (Wechsler, 1974). There were three groups of middle-class children: (1) Gifted - two or more standard deviations above the mean or IQ 130-155; (2) Superior - from one to two standard deviations above the mean or IQ 115-130; and (3) High Average - from the mean to one standard deviation above the mean or IQ 100-115. The lower-class children were also divided into three groups: (1) Superior; and (2) High Average - which were comparable to the corresponding ability groups in the middle-class children; and (3) Low Average - from the mean to one standard deviation below the mean or IQ 85-100. The distribution of subjects by age, sex, intelligence level,[2] and SES is presented in Table 1.

The gifted children were randomly selected from special classes for the intellectually and academically gifted conducted by the Israel Ministry of Education and Culture in two schools. The second and third middle-class groups were randomly selected from seven middle-class schools in the Greater Tel-Aviv area. The three lower-class groups were drawn from seven schools designated by the Israel Ministry of Education and Culture as deprived or disadvantaged. Criteria for this designation included educational leave and occupational status of parents, family income, and housing, all

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[1] Socioeconomic status will henceforth be referred to as SES.

[2] The four intelligence levels will henceforth be referred to as IQ groups.

Table 1

Number of Subjects by Age, Sex, IQ Group and SES

	IQ Group	Gifted: IQ 130-155 38				Superior: IQ 115-130 32				High Average: IQ 100-115 50				Low Average: IQ 85-100 22			
SES	Middle Class 80	Middle Class 32				Middle Class 19				Middle Class 28				Middle Class 1			
	Lower Class 62			Lower Class 6				Lower Class 13				Lower Class 22				Lower Class 21	
SEX	Boys 75	Boys 20		Boys 4		Boys 9		Boys 6		Boys 12		Boys 12		Boys 1		Boys 11	
	Girls 67		Girls 12		Girls 2		Girls 10		Girls 7		Girls 16		Girls 10		Girls 0		Girls 10
AGE	Grade Two 43	5	4	0	1	5	3	1	3	3	3	5	2	1	0	4	3
	Grade Five 51	9	5	0	0	2	3	4	3	3	5	3	5	0	0	4	5
	Grade Eight 48	6	3	4	1	2	4	1	1	6	8	4	3	0	0	3	2

Grand Total = 142

of which were well below the national standard for children attending these schools.

We had originally planned to compare children of each SES in each of the four IQ groups (130-155, 115-130, 100-115, and 85-100), and we sought them out in the public schools cited above. We found, however, very few middle-class children in the 85-100 range and relatively few lower-class children in the 130-155 range. We could have canvassed additional schools to fully constitute these two additional groups, but these groups would have been so atypical that generalizations from them to populations would be suspect. Accordingly we decided to confine the SES comparisons to the high average and superior IQ groups.

Materials

Original problem-solving: stringent solution-standard. Four tasks, two performance and two verbal, were selected from the research literature. The two verbal tasks, Crossing the River and The Oranges, were adapted for use with children from The Mined Road Problem (Lorge, Tuckman, Aikman, Spiegel & Moss, 1956) and The Pebbles (Debono, 1967), respectively. The examiner read each problem aloud and presented an accompanying picture. The two performance tasks, The Cylinder in the Can and The Two String Problem, were used without change and are described by Ray (1955).

Each test response was scored as (1) a solution or nonsolution; (2) popular or unusual, i.e., given by more or less than five percent of the group, respectively; and (3) of high or low quality, depending on (a) fit, the degree of match, appropriateness, or suitability of the response to the stimulus, and (b) cleverness or the degree of elegance and/or novelty of the response.

Detailed instructions for administration and scoring may be obtained from the investigator (Milgram, Arad,& Ramati, Note 1).

Four non-overlapping scores were computed for each subject: popular responses of high and of low quality, and unusual responses of high and of low quality. Each score was tabulated by adding the appropriate raw scores of the four items. The unusual high quality score included responses that, in addition to being statistically infrequent and clever, were also effective solutions to the problem. The other three scores included solutions and nonsolutions. Clever, unusual responses that did not solve the problem were included in the unusual low quality score. Means, standard deviations, and minimum and maximum scores for the four non-overlapping scores are presented in Table 2.

Original problem-solving: lenient solution-standard. The Tel-Aviv University Creativity Test was used. It is a battery of four tasks with four items per task and was adapted by Milgram and Milgram (1976a) from the Wallach and Kogan battery (1965). The four subtests were (1) alternate uses, (2) pattern meanings, (3) similarities, and (4) line meanings. Subjects responded to the verbal (1, 3) and the visual stimuli (2, 4) of this battery with verbal responses. The visual stimuli were presented on 8 x 14 cm. cards. This battery has been found to possess high internal consistency and homogeneity in Israeli middle-class children of average intelligence and above (Milgram & Milgram, 1976a, b; Milgram & Rabkin, 1980; Milgram et al., 1978).

Each test response was scored as either popular or unusual, i.e., given by more or less than five percent of the group, respectively. Detailed instructions for administration and scoring may be obtained from the investigator (Milgram, Arad,& Ramati, Note 1).

Table 2

Component Stringent Scores: Means, Standard Deviations, Minimum and Maximum Scores

	Mean	Standard Deviation	Minimum	Maximum
Popular High Quality	3.97	2.22	0	10
Popular Low Quality	7.28	2.34	3	17
Unusual High Quality	0.50	0.81	0	3
Unusual Low Quality	1.68	2.24	0	16

Two non-overlapping scores were computed for each subject, one for popular and one for unusual responses. Each score included responses of both high and of low quality and was tabulated by adding the appropriate raw scores of the eight items. Summed raw scores were used, rather than summed standard scores as in previous studies (Milgram & Milgram, 1967a, 1976b), because of the .95 correlation between the two reported by Rabkin (Note 2).

For several reasons responses on the lenient tasks were not scored as solutions or nonsolutions, or as high or low in quality. First, in the lenient task the distinction between solution and nonsolution is superfluous, since all or nearly all responses to stimuli in these tasks are considered solutions to the problem. In those rare instances where a subject gives a bizarre or inappropriate response to a particular stimulus, his response or even the entire protocol would be invalidated. In the present study no response was invalidated for this reason. In the stringent tasks, however, nonsolutions are relatively frequent and not necessarily bizarre at all. Hence, the necessity to score for solution-nonsolution in the latter, but not the former.

Our original intention was to score for high and low quality in lenient tasks as we had scored in stringent tasks. In scoring for quality two judges evaluate each response independently. This is a time-consuming and expensive procedure. Financial limitations compelled us to score for quality on only one of the two tasks. Since we had scored lenient tasks for quality in an earlier study, we elected to score stringent tasks for quality in the present study.

We had another reason for scoring quality in the stringent, rather than the lenient, tasks. In the earlier study, we (Milgram, et al., 1978) showed that little was gained by scoring separately for the high and low quality of unusual responses in lenient tasks. We found that the correlations of unusual responses of high quality to overall unusual responses was .89 and .88 for children in grades 4-6 and for youths in grade 12, respectively. Correlations of this magnitude may not occur in other age or intelligence groups, and in lower class subjects, but funds were not available to examine this question. Since there were no data on the value of quality scoring on stringent tasks for any group, it was decided to invest the time and effort here.

Intelligence Test. IQ scores were based on the Information and Vocabulary subtests of the WISC. Detailed information on administration and scoring are presented in the test manual (Wechsler, 1974). These subtests were selected because, like the original problem-solving tasks used in this research, they require verbal responding. This common response requirement increases the probability of obtaining a high correlation between intelligence and original problem-solving. If we do, in fact, obtain a modest or very low correlation, then we have impressive evidence for the discriminant validity of the original problem-solving tasks.

Procedure

Testing arrangements. Permission to test in the public schools was given by Mr. A. Yaron, Educational Inspector for the Greater Tel-Aviv area. The research plan was reviewed by the Research and Ethics Committee of the Israel Ministry of Education. The research coordinator visited each participating

school in advance and met with the principal to explain the purpose of the research and its requirements. As a result of this visit, each principal understood the research project, provided space for testing and for storage of testing materials between sessions, and arranged for the cooperation of the school personnel in the weeks that followed. Individual administration of all tasks took place in small examining rooms on the school premises during school hours.

The Examiners. The testing examiners were seven students, six women and one man, attending Tel-Aviv University. All examiners received two orientation sessions, one group and one individual, before they were permitted to administer the tasks; these sessions provided an explanation of the research project, a demonstration of the testing procedures, and the opportunity to practice them. The morale and cooperation of the examiners were excellent, and they maintained an acceptable standard of control over the testing procedure throughout. They received detailed guidelines for test administration, including the names of subjects to be tested in each class, alternate subjects in case of absences, the order of testing of subjects and of forms, and verbatim instructions to be read aloud to the children. Each examiner contacted the school to which he/she was assigned and personally coordinated the days and hours of testing.

Testing procedure. Tasks were divided into two alternate forms and individually administered in two sessions approximately one week apart. In the first session two lenient solution-standard subtests, one with verbal and one with non-verbal stimuli, and two stringent solution-standard tasks, one verbal and one performance, were administered alternately without verbal reinforcement.

In the second session a parallel set of materials was administered, and 110 of the 142 subjects received verbal reinforcement. This consisted of the examiner nodding approvingly and saying, "Good" following the first response to the stimulus, "Very good" following the second, and "Very fine" and "Excellent" for succeeding responses. There were no time limits for responding in either session. Biographical information about each subject was obtained at the beginning of the first session, and the modified WISC was administered at the end of the second session.

The combining of scores. Initial analysis of the data indicated that certain scores should be combined. First, it was decided to combine high and low quality responses on the stringent task to yield two rather than four non-overlapping scores -- popular and unusual. This decision was based on several considerations. It may be noted in Table 2 that the mean for unusual high quality responses on the stringent task is .50 with a range from zero to three. A narrow distribution of scores reduces the possibility of demonstrating reliable group differences on this measure even if they are in fact present. This problem arose because of the small number of stringent tasks as compared with lenient (four versus 16) and the high requirements set for clever, unusual solutions. Accordingly, unusual responses were treated as a single score, regardless of the quality or cleverness of the response in the stringent task.

The differentiation between high and low quality was also found to be unnecessary for the popular responses on the stringent task. Exhaustive analyses of the various subject groups, scoring separately for high and low quality popular responses, yielded equivalent results throughout.

Accordingly, the distinction in quality was dropped on popular as well as on unusual responses.

Second, the effects of verbal reinforcement and of practice were examined in a series of repeated measurement analysis of variance designs with the various subject groups. In none of these analyses was there a significant main effect for reinforcement or for practice (first session-second session); nor were there any significant interactions with these main effects. It was concluded that neither reinforcement nor practice made any difference on either lenient or stringent tasks. Given nearly equivalent means on first and second sessions and correlations of .82 and .55 for overall fluency measures for lenient and stringent tasks, respectively -- it was decided to collapse means of the two sessions in further analyses. These composite scores would yield a broader distribution than the separate session scores and would be more reliable than their components. Consequently they provide a better base for examining group differences and the other analyses dictated by the objectives of the research.

Chapter 3

INTELLIGENCE AND ORIGINAL PROBLEM-SOLVING: DISCRIMINANT VALIDITY

Theoretical Background

There have been few prior studies of creative thinking in lower SES children and in children of either middle or lower SES as young or as low in intelligence as those included in this study. Accordingly, a prior condition for the investigation was to demonstrate the discriminant validity of original problem-solving in these groups. By discriminant validity we mean that original thinking is empirically distinguishable from other cognitive constructs such as intelligence. In operational terms, evidence of discriminant validity consists of demonstrating that scores on tests of the ability to produce large numbers of ideas in general, and unusual ideas in particular, are relatively independent of scores on conventional intelligence tests.

Wallach (1970) concluded from a review of the literature that a minimum level of intelligence is required for the production of high levels of original thinking unconfounded with intelligence. This minimum level had not been specified for either middle- or lower-class children, but was assumed to be above some threshold around the middle of the range (Wallach, 1971). Our data for middle-class children indicated that (1) average to high average intelligence is the required minimal level when original think- is measured in group administration, but that (2) low average intelligence is sufficient in individual administration where response is oral rather than written (Milgram & Milgram, 1976b).

Ward, Kogan, and Pankove (1972) obtained discriminant validity in a group of lower-class fifth-graders below average in ability, when creative

thinking was obtained in individual administration. We (Milgram & Feingold, 1977) obtained a similar finding with lower-class seventh-graders of below average ability in Israel. In both of these studies, unfortunately, social class was confounded with intelligence level. Accordingly, it appeared warranted to investigate the discriminant validity of individually administered tasks of original problem-solving in young children, controlling both for intelligence level and for social class.

In previous studies of the relationship between intelligence and original problem-solving, only lenient solution-standard measures of the latter were utilized. It seemed reasonable to investigate whether stringent solution-standard measures were equally independent of intelligence. Accordingly, as a first step in the current research, we examined the correlation of intelligence and scores on both lenient and stringent measures to see if the two cognitive processes were empirically distinguishable from intelligence for the full range of age, sex, IQ group, and SES included in the study.

Results and Discussion

With the effects of age, sex, and SES partialed out, the correlations of the intelligence test scores with popular and unusual scores on the lenient tasks were .23, $p < .05$ and .14, $p < .05$, respectively; and the corresponding correlations for the two stringent scores were .28, $p < .001$, and .17, $p < .05$, respectively. The magnitude of these correlations is consistent with those reported by numerous other investigators and summarized by Wallach (1970).

The data of the current study support the Guilford (1956, 1967)-Mednick (1962) formulation of the distinction between intelligence and original

problem-solving. The findings extend their position by demonstrating (1) that stringent as well as lenient solution-standard original problem-solving is equally independent of intelligence; and (2) that original problem-solving can be measured using individual administration in children as young as age seven, as low in intelligence as 85, and in both middle and lower SES.

With reference to the distinction between intelligence and original problem-solving, two issues have been confounded, and this confounding has had serious consequences in research and in educational practice. One issue has to do with whether intelligence and original problem-solving are empirically distinguishable which they are, and the other with whether they are to be seen as equally valuable alternative cognitive strategies for problem-solving, which they are not. By itself convergent thinking is both necessary and sufficient for effective but uncreative problem-solving. Many scientific and/or aesthetic problems are solved by people who think systematically but not imaginatively. Original problem-solving may be imaginative, but unsystematic. If so, it is in and of itself insufficient to bring about effective problem-solving. Intelligence and original problem-solving must be combined and must constitute a dynamic process that involves <u>suspending</u> judgment to produce many unusual and imaginative ideas and <u>invoking</u> judgment in order to select the best ideas as effective and creative solutions to the problem.

Demonstrating the empirical distinction between intelligence and original problem-solving is, therefore, basic and a prior step to investigating the implications of differences in absolute level of originality scores in

individuals. However, once the former is achieved, other considerations become important. The measurement of originality is not an end in and of itself, any more than the measurement of intelligence is such an end. Psychometric instruments that obtain an empricial distinction between intelligence and original problem-solving are important mainly because they provide the means for educational programming and research to consider the implications of individual differences on these cognitive dimensions. Accordingly, in the current study we proceeded to examine the effects of age, sex, and SES on original problem-solving in gifted and nongifted children.

Chapter 4

THE EFFECT OF AGE, SEX, INTELLIGENCE, AND SOCIOECONOMIC STATUS

Theoretical Background

Much attention has been devoted by researchers to the investigation of individual differences in convergent problem-solving abilities as measured by conventional intelligence tests. Scant attention, by contrast, has been directed to examining individual differences in divergent or creative problem-solving abilities. Most studies of original problem-solving were done with middle-class preadolescents, adolescents and young adults within the relatively restricted range of average to high average intelligence and few developmental comparisons were attempted. Little is known, therefore, about the original problem-solving abilities of children who differ in age, intelligence, and SES. Previous studies were further limited in scope in that they utilized lenient solution-standard measures of original problem-solving ability only. In the current study we examined the separate and interactive effects of age, sex, intelligence, and SES on both lenient and stringent measures of original problem-solving in children across a wide range of age (grades two to eight) and intellectual ability (low average to gifted) in both middle- and lower-class groups.

Age. In the last 20 years increasing emphasis has been placed on the importance of identifying and enhancing the creative abilities of children (Getzels & Dillon, 1973). Numerous studies have investigated lenient tasks across a wide age range (five to adult), but relatively few studies have made explicit developmental comparisons, especially for preschool children (Arasteh & Arasteh, 1976; Torrance, 1962a; Wallach, 1970). Torrance (1962a) reported a steady rise between the first grade and adulthood on his

tests, but points to discontinuities that differ from culture to culture (1962b). The overall developmental trend specified by Torrance has been confirmed by other investigators, but not the rises and drops at different age levels (Long & Henderson, 1965; Ogletree & Ujlaki, 1973). Milgram et al. (1978) reported a developmental trend of increased production of unusual, but not popular, responses from grade six to twelve. By contrast, Iscoe and Pierce-Jones (1964) found no developmental increments in their subjects from age five to nine.

The apparent inconsistencies in the findings of the various studies are due to differences in the lenient tasks used, the scoring techniques selected, and the testing procedure employed. These studies vary on a number of dimensions: (1) verbal and nonverbal stimuli; (2) verbal and nonverbal response requirements; (3) lenient and stringent solution-standards; (4) scoring for frequency (popular versus unusual) and for quality (high or low); (5) reporting results as overlapping or non-overlapping scores; (6) individual or group administration; (7) timed or untimed administration, etc.

Given this state of affairs with reference to lenient measures and the absence of developmental data on stringent measures, there is high priority for developmental studies of original problem-solving in children from preschool age and up on both kinds of tasks.

Socioeconomic Status. Several investigators studied the relationship between social class and lenient measures of original problem-solving. They also examined differences in race and intelligence level. Their findings were complex and inconclusive.

Iscoe and Pierce-Jones (1964) found that lower-class children (ages five to nine) were higher in ideational fluency than middle-class children, but the former group was all black and the latter all white, thereby confounding social class and race. Saveca (1965) obtained the more conventional finding, that middle-class preschoolers did better than lower, but his study also confounded social class with race and with intelligence. Ogletree and Ujlaki (1973) also found middle-class children in several European countries higher on original thinking than their lower-class peers. Smith (1962) found a similar advantage for middle-class children on verbal tasks, but the reverse on nonverbal tasks.

The present study was characterized by two methodological advantages over earlier studies. First, social class and intelligence were unconfounded. The research design permitted a comparison of two intelligence levels within each social class and of the two social classes at the same intelligence levels. Second, stringent as well as lenient measures were investigated.

Sex. Few sex differences on original problem-solving have been reported in the literature (Maccoby, 1974), but this literature was largely confined to lenient measures. One might argue that there would be an advantage for boys over girls on the stringent measures, especially on tasks that require a restructuring or breaking of set and/or are visual-spatial in nature.

Intelligence. On the basis of the data presented earlier on discriminant validity, we would expect at best a weak main effect for intelligence level in the present analysis. However, interactions of intelligence with age, sex, and especially SES, if found by this analysis, would have important implications.

Results and Discussion

The appropriate analysis for examining main effects and their interactions with reference to the two lenient and the two stringent scores is analysis of variance, with age, sex, IQ group, and SES as factors. This analysis could not be performed because the absence of middle-class children in the low average IQ group and of lower-class children in the gifted group would have resulted in empty cells. Accordingly it was decided to analyze the data in two steps, the first examining the effect of SES alone and in interaction with age, sex, and IQ group, and the second investigating the effects of age, sex, and IQ group in each SES group.

We first investigated the main effect of SES and its interactions with the other three factors by computing a four-way analysis of variance, Age x Sex x IQ group x SES and including only the two IQ groups in which both SES groups were represented. We found a significant main effect for SES for unusual responses on the stringent tasks, F (1, 58) = 6.72, $p < .01$, with middle-class children giving more unusual responses than lower class; 2.51 and 1.31, respectively. There were no significant main effects for SES on the popular score of the stringent measure or on either popular or unusual scores of the lenient measure, and there were no significant interactions at all.

On the basis of the above findings we concluded that middle-class boys and girls in grades two to eight and in the 100-130 IQ range are higher than comparable lower-class children in generating unusual solutions to stringent tasks. Since the groups were comparable, this superiority cannot be attributed to differences in intelligence. This finding suggests that the environment of lower-class children not only contributes to the frequently documented

deficit in intelligence, but also to a more modest deficit in creativity.

Subsequently ,the other main effects and their interactions with one another were examined in separate analyses of variance for middle- and lower-class children with age, sex, and intelligence levels as factors in each. When the scores of middle-class children were analyzed, the three groups were gifted, superior, and high average; and when the scores of lower-class children were analyzed,the three IQ groups were superior, high average, and low average.

With reference to age, in nearly all instances there were no significant F ratios for age or its interaction with other factors. The only exception was a main effect for the middle-class children on popular responses to the lenient task, F (2, 61) = 5.03, $p < .01$. The means for the three age levels in ascending order were 48.04, 76.74, and 55.79, with the fifth grade higher than the other two grades ($p < .05$ by Scheffè). It should be noted that the corresponding means for the lower-class children were in the same direction (44.17, 60.29, 56.46), but they did not reach formal significance. Inspection of popular responses on the stringent measure also revealed a similar order by age (11.30, 12.44, 11.17 and 10.06, 11.17, 10.43 for middle- and lower-class children, respectively). No such trends were noted on unusual responses.

The current findings are consistent with those of Milgram et al. (1978) reported earlier and even clarify the developmental trend. By grade eight not only has popular responding ceased to increase, but it has, temporarily at least, declined. Furthermore, the findings of the current study indicate that the rise in unusual responding that was found for twelfth graders over

sixth graders has not yet begun in eighth graders. One possible explanation for these findings is that the onset of the rapid development of the ability to generate many unusual ideas is related to formal operations--an ability described by Piaget as appearing after grade eight. This is an empirical question worthy of investigation.

With reference to sex, there were no significant main effects or interactions on any of the analyses, with one exception. This was a significant sex x intelligence interaction on popular responses to the stringent task for middle-class children, F (2, 61) = 3.13, $p < .05$. Means and standard deviations of the six subgroups are presented in Table 3. Gifted girls, as might be expected, were the highest of the three intelligence groups for girls, but the gifted boys were lower than the superior boys. Why the gifted boys should perform less well is unclear. Since no similar sex x IQ group interaction was obtained for unusual responses on the stringent task or for either popular or unusual responses on the lenient ones, this finding is viewed with caution. The current findings are, therefore, consistent with those of previous studies summarized by Maccoby (1974) on lenient tasks and permit a broadening of the generalization of no sex differences to stringent tasks across a wide age and intelligence range in middle- and lower-class children.

Finally, as may be inferred from the foregoing reports on the other factors, there were no main effects for IQ group in any of the analyses. The single significant interaction of IQ group with the other factors was the one discussed in the preceding paragraph.

Table 3

Means and Standard Deviations of Popular Scores of Middle-Class Children on the Stringent Measure by Sex and IQ Group

	N	Boys	N	Girls
Gifted	20	11.60 (4,97)	12	13.92 (3.78)
Superior	9	13.44 (3.68)	10	10.40 (3.20)
High Average	12	10.75 (4.00)	16	10.44 (3.05)

Chapter 5

THE RELATIONSHIP OF QUANTITY AND QUALITY OF RESPONSE

Theoretical Background

Wallach (1970, 1971) summarized research on ideational fluency measures that demonstrated a strong relationship between the production of a large number of responses and production of responses that are statistically unusual, but not necessarily of high quality. Milgram et al. (1978) demonstrated that quantity, defined as popular responses and low-quality unusual responses, was strongly associated with quality, defined as unusual responses of high quality. Their study was conducted with middle-class sixth graders of high average to superior intelligence, but the conclusions do not necessarily apply to lower-class children, to other age and/or intelligence levels, or to tasks other than the lenient solution-standard. Hence, the importance of examining the relationship of quantity and quality of responses in stringent as well as in lenient tasks of original problem-solving in the children of the present study.

Results and Discussion

In the current study, quantity is defined as popular responses, and quality as all unusual responses. The rationale for these definitions was discussed previously (see pp. 6, 12-13). The correlations between quantity and quality scores in both lenient and stringent measures were computed for all 142 subjects with the effects of age, sex, IQ group, and SES partialed out. Subsequently, correlations were computed for each social class with the remaining variables (sex, age, and IQ group) partialed out, and so on for the separate sex, age, and IQ groups. These correlations are presented in Table 4. In this table and in succeeding tables, the .05 level of

Table 4

Partial Intercorrelations of Quantity and Quality Scores of Lenient and Stringent Measures by Age, Sex, IQ Group and SES

	Total (N=142)	Boys (N=75)	Girls (N=67)	Middle SES (N=80)	Low SES (N=62)	Grade 2 (N=43)	Grade 5 (N=51)	Grade 8 (N=48)	IQ130 (N=38)	IQ115-130 (N=32)	IQ110-115 (N=50)	IQ85-100 (N=22)
Popular Lenient-Unusual Lenient	.84***	.88***	.82***	.87***	.78***	.81***	.86***	.85***	.91***	.85***	.74***	.90***
Total Lenient-Unusual Lenient	.97***	.98***	.96***	.98***	.95***	.96***	.98***	.97***	.99***	.95***	.94***	.98***
Popular Stringent-Unusual Stringent	.54***	.56***	.58***	.65***	.24*	.46***	.66***	.38**	.70***	.53**	.44***	.07
Total Stringent-Unusual Stringent	.82***	.85***	.80***	.88***	.56***	.80***	.88***	.69***	.89***	.87***	.72***	.59**

of significance is indicated by one asterisk, the .01 level by two asterisks, and .001 by three. The number of subjects in this table and in all subsequent tables appears in parentheses under the heading of each column.

It may be noted that the quantity-quality correlations on the lenient tasks range from .74 to .90 for 11 subgroups and is .84 for the entire sample. Correlations of this magnitude constitute impressive evidence for a generalized quantity-quality relationship and are of the same magnitude as the correlations reported by Milgram et al. (1978) in children and adolescents. On the basis of these findings we conclude that this relationship obtains in middle- and lower-class children across a broad age range from seven to 17 and from low average to gifted intelligence levels.

One might argue that we have only demonstrated a relationship between popular and unusual responses and that the relationship of quantity (all responses other than unusual responses of high quality) and quality (all unusual responses of high quality) remains to be demonstrated in our sample. In reply, it may be pointed out that the whole-part correlation of all unusual responses to unusual responses of high quality in the earlier study (Milgram et al., 1978) was .88. Assuming a correlation of similar magnitude in the present study, we may conclude that the popular-unusual correlations are the equivalent of the quantity-quality correlations. It may be recalled that financial limitations prevented us from scoring unusual responses on the lenient tasks for quality. Nevertheless, numerous comparisons of the findings in the present project with data from the earlier study (Milgram et al., 1978) yielded highly consistent findings between the two studies; therefore, our assumption of comparability of quantity-quality in the two appears reasonable.

With reference to the stringent tasks, the correlations of popular and unusual responses are also highly significant in most comparisons. The magnitude of the correlations presented on Table 4 ranges from .38 to .70 for nine groups and is .54 for the entire sample. Only the lower-class children constitute an exception to this trend, and their data are discussed below. Apart from lower-class children, one may conclude that the quantity-quality correlations obtained here constitute strong evidence for the importance of overall ideational output as a condition of the production of unusual responses of high quality in stringent as well as in lenient tasks of original problem-solving.

If we now turn to the correlations obtained on stringent tasks by lower-class children, we find a low significant correlation overall (.24) as compared with that of middle-class children (.65). In addition, the correlation for children of low average intelligence is not significantly different from zero (.07) and it should be recalled that 21 of 22 children in this IQ group are drawn from the lower class.

Since there was no difference in the magnitude of correlations between lower- and middle-class children on lenient tasks, it might be argued that the lower correlations on the stringent tasks of the former arise from their restricted range of scores on the stringent tasks. If we examine the means and standard deviations (in parentheses) of popular and unusual responses on the stringent tasks for lower-class children, 10.77 (3.29) and 1.39 (1.32), respectively; and for the low-average IQ group, 9.50, (2.58) and 1.23 (1.41); we find that this notion is untenable. The range on these measures is the same for lower- and for middle-class children.

In an earlier section we reported middle-class children to be superior to lower-class children in giving unusual responses to stringent tasks. In this section we found that popular and unusual responses were more highly related in middle- than in lower-class children. The explanation for these differences is not readily evident. It may be related to the special nature of the stringent tasks for lower-class children. This question requires further investigation.

The correlation of whole to part was next examined to ascertain the extent to which the overall fluency score, which is easily obtained by counting, is an adequate predictor of the unusual score, which requires tedious tabulation of response frequencies to identify the 5% level. The correlations of total number of responses and the subset of unusual responses are presented in Table 4. It may be noted that the 12 correlations are substantially higher for both lenient and stringent tasks than the corresponding correlations based on non-overlapping scores.

The whole-part correlations are so high for the lenient task, ranging from .94 to .98, that it appears pointless to score for unusual responses, since the overall score is almost equivalent in correlational terms. The whole-part correlations are also impressive in the stringent task, where they range from .56 to .89. Here too it is the lower-class children whose correlations lower the overall correlations. The correlation is .88 and .56 for middle- and lower-class children, respectively, and this difference affects the other groups in which middle- and lower-class children are combined.

One may conclude that fluency or overall scores are highly adequate estimates of unusual responses in lenient and stringent tasks for middle-

class children and on lenient tasks for lower-class children. The overall fluency score is a somewhat less adequate estimate of unusual responses in stringent tasks for the lower-class children.

Chapter 6

A DEVELOPMENTAL VALIDATION OF MEDNICK'S ASSOCIATIVE HIERARCHIES OF ORIGINAL PROBLEM-SOLVING

Theoretical Background

Mednick's hypothesis (1962) on the nature of creative process has been one of the major conceptualizations underlying research efforts in creative thinking or original problem-solving (Wallach, 1970). Our work has been influenced by this formulation of the creative process, a verbal learning model that attributes a critical role to ideational fluency and that postulates quantity of ideational fluency to be a precondition for quality responding. This hypothetical description of the creative process applies equally to solving intellectual problems of a general nature in a wide variety of life situations as well as to solving problems in specific areas of talented accomplishment such as art, drama, music, mathematics, engineering, etc.

Mednick (1962) proposed that the process of creative thinking follows the model of word association. He postulated a hierarchy of responses to a stimulus word, i.e., an order effect based upon the relative associative strength of each response. The stronger associates--the more conventional, stereotyped, or popular responses--are higher in the hierarchy, more easily accessible and more likely to be emitted earlier in the response sequence. The weaker associates--the more unusual responses--are more likely to be emitted later in the response sequence. More of the unusual responses occurring later in the sequence, is a phenomenon referred to subsequently in this paper as an order effect.

Mednick further postulated different associative response hierarchies for low and high creative persons. Low creatives are characterized by a steep and short gradient, with many popular responses at the beginning, but once these responses are exhausted, fewer unusual responses subsequently. High creatives, by contrast, are characterized by a shallow and extended gradient, with fewer popular responses than low creatives initially, but with many more unusual responses subsequently.

A number of investigators reported the scores on Mednick's test of creativity, the Remote Associates Test, to be related to successive word associations (Mednick, 1962; Mednick, Mednick, & Jung, 1964; Riegel, Riegel, & Levine, 1966). Brown (1973) found differences on a paired-associate learning task between people designated high and low creatives according to RAT scores. These findings--that highly creative people gave more responses and, therefore, more unusual responses than low creatives, and that they learned low-strength paired-associatives as easily as high-strength--were interpreted as validations of Mednick's associative theory of creativity.

One of Mednick's postulates was not confirmed. He expected a higher initial response rate for popular responses in low creative persons than in high creative (Mednick, Mednick & Jung, 1964). He found, however, as have other investigators (Bousfield & Sedgewick, 1944; Bousfield, Sedgewick, & Cohen, 1954; and Ward, 1969) that the opposite is true: high creatives give more popular responses initially than low creatives.

Mednick, Mednick, and Jung (1964) cited a methodological limitation in their study: they gave subjects only two minutes to respond to each stimulus word. They suggested that giving subjects unlimited time would

permit the entire response repertoire of high and low creatives to emerge. This would result in a more complete picture of the relationship between level of creative thinking and associative responding.

In the first study to investigate the sequence of creative responding in children, Ward (1969) found that common responses decreased and unusual responses increased over time in seven and eight year olds. He did not, however, obtain different response hierarchies for high and low creative children as postulated by Mednick. Ward attributed this to methodological limitations of his study, in which group comparisons were made only during that portion of the response sequence when both groups continued to respond, thereby failing to consider the entire response reservoir of the high creative subjects who persisted in responding long after the low creatives had ceased to respond. Ward indicated that the difference between high and low creative subjects may lie precisely in this part of the response sequence--when high creative people continue to emit responses of weak associative strength, and low creatives, having exhausted their repertoire of high associative strength responses, cease responding altogether.

Developmental differences in associative hierarchies were investigated in only one study. Milgram and Rabkin (1980) examined the response sequence in creative thinking using lenient tasks in 90 children, 30 each at ages 9, 12, and 17. Children were designated as high or low creative if they were above or below the median in number of unusual responses of high quality. In accordance with Mednick's formulation, a more pronounced order effect (more unusual responses in the second half of the sequence) was expected in the response hierarchies of high than of low creative children. It

was also expected that the order effect would be stronger for older than for younger children. Given an age-related increment in unusual responses from sixth to twelfth grade (Milgram et al., 1978), it appeared reasonable that the order effect would be more pronounced in the older children.

Previous studies have been limited to the examination of the order effect of unusual responses regardless of quality (Mednick, 1962; Mednick, Mednick, & Jung, 1964; Ward, 1969). In the Milgram and Rabkin study (1980), however, the order effect was examined both for unusual responses of high and of low quality. Given the assumption that unusual responses of high quality are fewer in number, are characterized by weaker associative strength, and are less available than unusual responses of low quality -- these investigators predicted that there would be a more pronounced order effect for the former kind of response than for the latter.

It may be recalled that a time limit on associative responding was cited by Mednick, Mednick, and Jung (1964) and Ward (1969) as a major limitation of earlier efforts to clarify differences between high and low creative people. In the Milgram and Rabkin study (1980) the time limit was eliminated, and the entire reservoir of responses for all subjects was included in all analyses.

The results of this study were consistent with the Mednick formulation. There was an increase in the number of unusual responses in the course of sequential responding. This order effect obtained not only in unusual responses of high quality, but also in unusual responses of low quality; the effect was more pronounced, however, in the former than in the latter.

There was a significant triple interaction of Order x Age x Level of Creative Thinking, indicating that the order effect was not uniform across age and creative ability. The order effect did not obtain at all at age 9, regardless of level of creative thinking. It obtained at age 12, but only for the high creatives, and it obtained at age 17 both for low and for high creatives. These findings appear to qualify Mednick's postulate of a generalized order effect by indicating its emergence between 12 and 17 for everyone and earlier for high creative children.

Numerous studies of Mednick's formulation with college students had yielded results consistent with those of the oldest of the three age groups in the above study. Accordingly it did not seem necessary to replicate these findings by including 17-year-olds in the current study. On the other hand, the Milgram and Rabkin study (1980) was the first to examine the response sequence in children ages 9-10 and 12-13. A replication study on the response sequence including these ages appeared worthwhile. Similar considerations led to the inclusion of children of ages 7-8 in the current study. It may be recalled that only one previous study had been conducted with children of ages 7-8 (Ward, 1969), and that this study was flawed in that a time limit was imposed on associative responding. Accordingly, in the current study we examined the order effect of popular and of unusual responses in children of age 7-8 and in the two groups of children whose ages corresponded approximately to the two younger age groups of the earlier study.

The design of the current study permitted us to examine the associative hierarchies of original problem-solving (a) as a function of age, sex, intelligence level, and SES and (b) as a function of stringent as well as lenient tasks.

Results and Discussion

In the first analysis we included only the two IQ groups in which both SES groups were represented. We examined the unconfounded effect of SES and intelligence level. Subjects were divided into high and low creative groups on the basis of their unusual responses, i.e., above and below the median. In this and in all subsequent analyses when the lenient scores were examined, the lenient unusual score constituted the basis for the median split; when the stringent scores were examined, the stringent unusual score was used for the median split.

The popular and unusual scores of both lenient and stringent measures were subjected to separate four-way analyses of variance, Order of Occurrence (first half versus second half of one's response sequence) x Level of Creative Thinking (high, low) x IQ Group (Superior/High Average) x SES, with the first factor constituting a repeated measurement. There was no interaction of SES with Order or with the other variables. On the basis of these findings, it was concluded that the order effect does not operate selectively as a function of SES.

It was not possible to compute an overall five-way analysis of variance, with repeated measurement, Order (First Half/Second Half) x Level of Creative Thinking x Sex x IQ Group (Gifted/Superior/High Average/Low Average) because it would have resulted in empty cells. We, therefore, performed three separate four-way repeated measurement analyses of variance . These statistical analyses were designed to investigate all possible main effects and interactions of the five variables.

With reference to the lenient measure, we obtained in all analyses a significant main effect for Order and a significant interaction of Order

with Level of Creative Thinking for both popular and unusual scores. The *F* ratios for Order (*df* = 1,130) were 138.54 and 134.36, *ps* < .001, for the popular and unusual scores, respectively. The corresponding *F* ratios (*df* = 1,130) for the Order x Level of Creative Thinking interaction were 32.57 and 33.92, *ps* < .001, respectively. Means and standard deviations relevant to these results are presented in Table 5. The findings indicate an increase in the number of unusual responses and a corresponding decrease in the number of popular responses in the course of sequential responding for both high and low creative subjects. Moreover, the findings demonstrate the phenomenon to be more pronounced in high than in low creative subjects.

With reference to the stringent scores, we obtained a significant main effect for Order, *F* (1,130) = 10.81, *p* < .001 and for the interaction of Order and Level of Creative Thinking, *F* (1,130) = 3.80, *p* = .05 for popular responses. Means and standard deviations relevant to these results are presented in Table 5. There was an order effect for high creative children, but none for low. There was, however, a significant triple interaction of Order x Level of Creative Thinking x Sex, *F* (1,130) = 4.80, *p* < .05, which indicated that the order effect was confined to the high creative boys. A similar trend was found for unusual responses on the stringent task with a corresponding significant triple interaction, *F* = 8.46, *p* < .01, and with identical implications: an order effect for the high creative boys only.

It is clear why more impressive and generalized order effects were found on lenient tasks than on stringent. Since the items on the latter tasks were more difficult, subjects gave fewer responses overall and therefore, fewer unusual responses. The mean unusual scores for stringent were

Table 5

Lenient and Stringent Scores: Means and Standard Deviations of First and Second Half Scores of High and Low Creative Subjects

	Total N		High		Low	
	First Half	Second Half	First Half	Second Half	First Half	Second Half
Lenient						
Popular	32.54 (17.24)	25.66 (11.47)	42.12 (20.42)	31.63 (13.33)	23.97 (6.05)	20.33 (5.59)
Unusual	9.78 (16.46)	16.50 (23.04)	17.18 (21.68)	27.57 (29.83)	3.17 (1.77)	6.61 (2.81)
Stringent						
Popular	5.91 (2.32)	5.34 (1.85)	6.54 (2.67)	5.63 (2.15)	5.26 (1.67)	5.04 (1.42)
Unusual	0.85 (1.07)	0.96 (1.70)	1.49 (1.14)	1.71 (2.11)	0.19 (0.39)	0.20 (0.40)

only 1.60 and 0.19 for high and low creative children, respectively. With so abbreviated a response sequence, the division into high and low creative subjects at the median is less reliable than the division in the case of the lenient tasks, where the means of unusual responses for high and low creatives were 22.37 and 4.89, respectively. The order effect is an unstable phenomenon when based on few responses.

This line of reasoning is supported by the fact that the only subjects to give a demonstrable order effect were the high creative boys, whose mean was, in fact, higher than that of the girls ($F = 6.69$, $p < .01$)--1.82 and 1.31, respectively. These boys gave more unusual responses than the girls, thereby making it more possible for an order effect to obtain in their response sequence.

We therefore regard the data on stringent tasks as consistent with the Mednick formulation of an order effect. If items were designed to generate a larger number of unusual solutions, a more impressive overall order effect would have obtained especially for high creatives.

In summary, the findings of the current study provide strong empirical validation for the Mednick hypothesis of an associative basis for the process of creative thinking and extend the hypothesis by demonstrating the order effect for children in both middle and lower classes, as young as age seven, who vary in intelligence from low average to gifted.

While the magnitude of the order effect is highly significant statistically, the phenomenon was not found to be all-or-none in either our previous work (Milgram & Rabkin, 1980) or in the current study. Many popular responses are given later in the list, and many unusual responses are given earlier.

These findings suggest that the steep associative hierarchy of the low creatives is somewhat more shallow than that envisioned by Mednick. By the same token, the greater number of popular responses given by the high creatives in this study and in previous investigations suggests that the shallow associative gradient of high creative persons probably begins at the same level on the ordinate as the steep gradient of the low creatives--or even above that level--and not below that level, as originally proposed by Mednick.

The current data of a generalized order effect may appear to contradict our earlier finding on children ages 8-9 and 12-13 (Milgram, & Rabkin, 1980). We reported that the order effect was developmental in nature, appearing only between age 12 and 17 except in highly creative children, where it obtains earlier, between age 9 and 12 (Milgram, & Rabkin, 1980). One explanation for the different findings in the two studies is the difference in administration. In the current study individual administration was utilized, children responded orally and examiners recorded the responses. An impressive order effect was found at all ages even for low creative children. By contrast, in the earlier study group administration was utilized, children had to write down their own responses, and only the older and more creative children manifested an order effect before adolescence. It may be that the writing of responses, one after the other, disrupts the implicit response hierarchy for children at young ages and low levels of creative thinking.

Chapter 7

THE VALIDITY OF LENIENT SOLUTION-STANDARD TASKS AS PREDICTORS OF STRINGENT SOLUTION-STANDARD CRITERION MEASURES

Theoretical Background

Many theorists have described creative thinking as a kind of original problem-solving operation, which generates new information from known and remembered information (Guilford, 1967; Maier, 1970; Wertheimer, 1945). Mednick (1962) defined creative thinking as "the forming of associative elements into new combinations which either meet specified requirements or are in some way useful." Davis (1973) defined a problem as a stimulus situation for which an organism does not have a ready response, and a solution or creative idea as a new combination of existing ideas.

It has been empirically demonstrated that (1) ideational fluency is a cognitive capacity distinct from intelligence (Wallach, 1970, 1971); (2) there is a strong relationship between the quantity and quality of ideational output (Wallach, 1970, 1971; Wallach, & Kogan, 1965; Milgram et al., 1978); and (3) there is a difference in the associative response hierarchies of high and low creative people (Mednick, 1962; Milgram & Rabkin, 1980; Ward, 1969).

These findings were interpreted as providing empirical support for the validity of using measures of ideational fluency as predictors of original problem-solving in practical life situations. This generalization is premature, however, because of a basic difference between predictor and criterion tasks. The former tasks are subject to lenient standards for solution, whereas most life tasks are subject to stringent standards

for solution. The validity of the former as predictors of the latter remains, therefore, to be demonstrated.

Relatively few studies have dealt with this issue. Mednick (1962) demonstrated a strong relationship between associative productivity and scores on a stringent-standard criterion measure of original problem-solving, the Remote Associates Test or RAT, where there is one correct solution to a problem. He inferred that in the process of solving a RAT problem, subjects give many solutions before arriving at an original correct solution. However, since subjects report only one solution, Mednick could not directly compare quantity and quality of associative productivity with quantity and quality of solutions to RAT problems. Brown (1973) found that the relative ease of learning low-strength paired associates, a task assumed to reflect associative productivity, was related to RAT scores. In his study, ideational productivity was assumed on both predictor and criterion tasks, but not demonstrated on either. The above findings are consistent with the formulation linking ideational fluency and original problem-solving, but do not demonstrate the relationship conclusively.

In one of the few studies in this area, Goor and Sommerfeld (1975) studied problem-solving processes in creative and noncreative college students. They analyzed the quantity, quality, and sequence of ideational production in solving three stringent solution-standard laboratory problems and reported data consistent with the Mednick (1962) model. Creative students spent more time generating new information and developing hypotheses than noncreative students who spent more time in silence.

Houtz and Speedie (1978) used a wide variety of factor analytic techniques to examine scores of fifth graders on 12 measures of problem-solving. They isolated three factors; the first two are similar to those described above as lenient and stringent solution-standard problem-solving, respectively, and the third is school achievement. The first factor accounted for 60-65% of the total variance, the second for 20-30 and the third for 10. Unfortunately, Houtz and Speedie (1978) did not distinguish among responses on the basis of frequency (popular versus unusual) and quality (high versus low) or between solutions and nonsolutions. These additional scoring procedures would further clarify both the internal structure of the two factors and the relationship between them.

The present investigation is the first to score for quantity and quality of response both in a lenient predictor and in a stringent criterion measure, and to assess the empirical validity of the corresponding predictor and criterion scores.

Results and Discussion

The correlations between the two overall fluency measures of the lenient and stringent tasks, between the two respective popular measures, and between the two respective unusual measures are presented in Table 6. In order to determine differences in the magnitude of the correlations being investigated, we examined the relationships separately in each age, Sex, IQ, and SES group. In each instance we computed partial correlations controlling for all independent factors except the one being examined. The correlation coefficients by subgroups are also presented in Table 6.

Table 6

Partial Correlations of Lenient and Stringent Scores

by Age, Sex, IQ Group and SES

	Total (142)	Boys (75)	Girls (67)	Middle-Class (80)	Lower-Class (62)	Grade 2 (43)	Grade 5 (51)	Grade 8 (48)	Gifted (38)	Superior (32)	High Average (50)	Low Average (22)
Total Lenient-Total Stringent	.59***	.61***	.61***	.62***	.50***	.50***	.70***	.42**	.73***	.58***	.52***	.49*
Popular Lenient-Popular Stringent	.59***	.57***	.65***	.64***	.49***	.54***	.73***	.37**	.67***	.73***	.54***	.35
Unusual Lenient-Unusual Stringent	.47***	.46***	.53***	.48***	.42***	.42**	.54***	.35**	.66***	.16	.45***	.54**
Total Lenient-Unusual Stringent	.51***	.49***	.60***	.54***	.42***	.44**	.59***	.41**	.67***	.32*	.56***	.46*

Strong correlations, ranging from .42 to .70, were obtained between the lenient and stringent scores for overall fluency for the total sample and for the 11 subgroups. With one exception, correlations of similar high magnitude were obtained between the corresponding popular lenient and stringent scores and the corresponding unusual scores. The correlations of lenient and stringent popular scores ranged from .35 to .73 and the corresponding unusual scores from .42 to .54.

The findings provide impressive support for the construct validity of the Mednick-Guilford conceptulization of original thinking. The ability to generate many unusual high-quality responses to problems where almost any response qualified as a solution is a valid predictor of the ability to produce original productions to problems where stringent criteria apply for what constitutes a solution.

The overlapping overall fluency score, i.e., total number of responses on a lenient solution-standard task, is the most frequently used predictor of stringent standard original problem-solving ability. The partial correlations of this score with the unusual score on the stringent task for the total sample and for the 11 age, Sex, IQ, and SES groups are presented in Table 6. These correlations ranged from .32 to .67 and are as high as those obtained by using the unusual score in the lenient task as the predictor. Since the first predictor is easily obtained by counting discrete responses, while the second predictor requires calculating statistical frequency, the former is a more economical and efficient method of assessing stringent standard original problem-solving.

The corresponding overlapping score, overall fluency on the stringent solution-standard task, was an even better index of unusual responses in stringent standard problem-solving. These correlations, which ranged in magnitude from .56 to .89, are presented in Table 4. Stringent tasks have an additional advantage over lenient in possessing higher face validity. If stringent tasks were adapted for group administration, at least for older children, they would be clearly preferable on all counts.

Lenient solution-standard tasks of original problem-solving are frequently used as measures of creative ability, but have low predictive validity with reference to creative attainments in science, music, art, drama, etc. (Crockenberg, 1972; Milgram & Milgram, 1976a; Wallach, 1971; Wallach & Wing, 1969). Since the quality of real-world creative behaviors is judged by stringent rather than lenient standards, they are probably better predicted by stringent than by lenient solution-standard measures. This question is currently under investigation.

Chapter 8

THE EFFECT OF VERBAL REINFORCEMENT ON ORIGINAL PROBLEM-SOLVING

Theoretical Background

One objective of this research was to investigate the effect of verbal reinforcement on the quantity and quality of original problem-solving in children as a function of age, sex, IQ group, and SES. As mentioned earlier in this report (see page 13), an overall reinforcement effect was not found. Nor were there reinforcement effects for any particular group of subjects. In this chapter I would like to cite the research that led to this objective and to offer explanations for the findings that emerged.

Several studies have been done on the effects of concrete incentives on original problem-solving in children. Ward, Kogan, and Pankove (1972) reported that concrete incentives increased total number of responses to the Wallach and Kogan battery in fifth graders. Johnson (1974) obtained similar results with promises of rewards to disadvantaged, rural third to fifth graders. By contrast, Kruglanski, Friedman, and Zeevi (1971) found that tangible rewards lowered the performance of middle-class children. Moran and Liou (Note 3) found that tangible reward facilitated original responding in students of low intellectual ability, but was detrimental to the performance of high ability students.

Milgram and Feingold (1977) conducted one of the few studies comparing the effects of verbal and concrete reinforcement on creative thinking. They found that both were effective in increasing the number of overall responses in disadvantaged seventh graders. In comparison with baseline, children produced the greatest increment in number of responses when rewarded with concrete reinforcers, somewhat less of an increment with verbal reinforcers,

and no increment when they received no reward for their effort. These findings were interpreted as indicating that creative thinking could be added to the growing list of behaviors amenable to behavior modification by means of contingency management. The authors suggest that teachers should be trained for the task.

Since verbal reinforcement was found to be almost as effective as concrete reinforcement in the Milgram and Feingold (1977) study, their suggestion for implementation in educational practice seemed reasonable. Prior to implementing such training of teachers on a large scale, however, more research seemed indicated. The findings cited above demonstrated that concrete reinforcement had differential effects on creative thinking in middle - versus lower-class children (Johnson, 1974; Kruglanski, Friedman, & Zeevi, 1971) and in students of high versus low intellectual ability (Moran & Liou, Note 3). It seemed worthwhile, therefore to investigate whether verbal reinforcement might also have differential effects on children of different age, intelligence level, and SES. Moreover, all of the studies cited above were limited to a single score, i.e., overall number of responses on a lenient measure. The effects of verbal reinforcement on quantity versus quality scores of both lenient and stringent measures of original problem-solving was a research question worthy of investigation.

We therefore conducted two studies on these questions, one with college students (Milgram & Arad, Note 4) and the current study. In the former study, verbal reinforcement had no effect on either quantity or quality scores of lenient or stringent measures. Details on this study are available from the authors. The findings of the current study are presented below.

Results and Discussion

It was not possible to include all variables in a single overall analysis because it would have resulted in empty cells. Since no contributory sex differences had been obtained on either lenient or stringent measures (see page 23), we did not expect any in the current analysis. We examined the effect of sex in interaction with reinforcement by performing a repeated measurement analysis of variance, Time (pre/post) x Reinforcement x Sex, on the two lenient and the two stringent scores. As expected, no interaction of reinforcement and sex was obtained.

In the next analysis we included only the two IQ groups in which both SES groups were represented, and we examined the unconfounded effects of SES and of intelligence level. We subjected pretest and posttest scores of both lenient and stringent solution-standard measures to four-way repeated measurement analyses of variance: Time (pre/post) x Reinforcement x SES x IQ Group (superior/high average). There were no main effects and no interaction of SES with the other variables on any analysis.

The only significant finding was a triple interaction of Time x Reinforcement x IQ group, F (3,134) = 3.19, $p < .05$ on popular responses in lenient tasks. When the relevant means were examined, it was found that there was a positive reinforcement effect for high average children, but none for the children of superior intelligence. This finding would appear to suggest that only the lower of the two IQ groups benefits from verbal reinforcement on lenient tasks. On this basis, we would expect that an analysis of all four IQ groups would show the low average group to benefit and the gifted to be unaffected or to be impaired in performance.

Analysis of variance with repeated measurement, Time x Reinforcement x IQ Group (gifted, superior, high average, low average), yielded the same triple interaction obtained earlier, $\underline{F} = 3.19$, $\underline{p} < .05$, and no other main effects or interactions. When the eight means were examined, however, it was found that only the high average group benefited from reinforcement. Not only were the two higher IQ groups (superior and gifted) unaffected by reinforcement, but even the IQ group that was lower in intelligence (low average) failed to benefit from reinforcement. Accordingly, we conclude that there is no consistent trend for the lower IQ groups to benefit from reinforcement as compared with the higher groups.

We, therefore, tended to discount the single significant finding because it obtained only popular responses to lenient tasks. If the reinforcement effect were genuine, one might expect it to affect other measures, unusual lenient responses, or popular and unusual stringent responses. Accordingly, we conclude that verbal reinforcement had no effect on the lenient and stringent tasks of original problem-solving.

This finding runs counter to earlier research in which verbal reinforcement had a positive effect on response production in lenient tasks with disadvantaged children. One might have expected the lower-class children in the present study to behave in a similar fashion, at least on the same lenient tasks, as subjects in the earlier study (Milgram, & Feingold, 1977).

One explanation is that in the present study lenient tasks were not administered alone in baseline and then a second time in the reinforcement phase. Both lenient and stringent tasks were included in the present design: first, two lenient tasks were given in baseline followed by two stringent

tasks, and then two lenient and two stringent tasks in the reinforcement phase. This administration of lenient and stringent tasks, both in baseline and in the reinforcement phase, may interfere with the maintenance of a mental set conducive to and susceptible to verbal reinforcement. Further support for this explanation may be found in the study with college students (Milgram & Arad, Note 4), where similar findings, i.e., no effect of verbal reinforcement, were obtained in a design alternating lenient and stringent measures in baseline and reinforcement phases.

The explanation for our failure to obtain a reinforcement effect may lie in a different methodological problem. The laboratory setting in which the children responded to the various tasks and the continuous reinforcement which they received may not have been sufficiently ecologically valid. The efficacy of verbal reinforcement is affected by many subtle variables in the context in which it is given. Investigation of the effects of verbal reinforcement on original problem-solving in the home or at school, settings that are ecologically more valid, may yield different results.

Chapter 9

OVERVIEW OF THE FINDINGS

The current study is one of the first to examine creativity, defined as original problem-solving in children, across a wide range of age, intellectual ability, and social class. The findings provide strong empirical support for the formulation of ideational fluency as a critical cognitive component of the creative process in children and as one that is relatively independent of the abilities measured on conventional intelligence tests.

Three sets of findings provide impressive support for the construct validity of the Mednick-Guilford conceptualization of original thinking. The most important finding was the consistent relationship between lenient predictor measures and stringent criterion measures of original problem-solving in children representing a wide range of age, intelligence level, and socioeconomic status. Lenient solution-standard tasks of original problem-solving are frequently used as measures of creative ability. Unfortunately, few studies have demonstrated the validity of these measures as predictors of real-world creative behaviors, which are generally judged by relatively stringent standards. The current findings indicate that performance on lenient tasks is strongely related to performance on laboratory problems with stringent solution-standards. This is a step in the direction of demonstrating predictive validity.

The second set of findings supports the Mednick position that original thinking follows the model of word association, with popular responses occurring earlier in the response sequence and unusual responses later. The data extend this position by demonstrating that this general phenomenon appears in children as young as seven years old and is greater for high creatives than for low.

The third set of findings clearly demonstrates that the ability to generate many solutions to a problem is strongly associated with the ability to produce a few original solutions of high quality. We found a strong relationship between quantity and quality of response in original problem-solving in children within both lenient and stringent solution-standard tasks. The findings of similar internal structure in lenient and in stringent tasks provide additional evidence of the validity of the former as a predictor of the latter.

Differences were found as a function of social class but not intelligence. Middle-class children generated more quality responses on stringent tasks and the relationship of quality to quantity of response was stronger. These findings suggest that SES differences may obtain on some kinds of creative performance and not on others.

In some spheres of human endeavor, fewer women make outstanding creative contributions than men. This difference cannot be explained by a sex-related cognitive deficit. In the current study, girls and boys were equal in original problem-solving ability. The reasons for the underrepresentation of women may well be found in the realm of socialization.

The findings support the Mednick position that creative thinking follows the model of word association when viewed <u>microgenetically</u>. The findings are not to be interpreted as implying that creative thinking follows this model when viewed <u>ontogenetically</u>. If creative thinking were to follow the word association model, we would expect an increase in popular responses and a decrease in unusual responses with age as reported in the word association literature (Entwistle, 1966; Sheehy, 1964). If, on the other hand,

the developmental processes associated with creative thinking are cognitive in nature and, therefore, similar to those of intelligence, we would expect qualitative rather than quantitative age-related changes. Older subjects would differ from younger more in the increased number of high level abstract and complex novel ideas acquired than in the increased number of popular ideas acquired. In the current study popular responding decreased after grade five in every age and SES group. These findings provide more support for a cognitive than for an associative explanation of the ontogenetic process in creative thinking.

Feldman (1974) has argued convincingly that the creative process is best seen within a Piagetian developmental framework, but there has been little empirical work on the specifics of stage development of creative thinking. The findings of the current study in conjunction with our earlier study (Milgram et al., 1978) demonstrate age-related increments in unusual, but not in popular, responding. Unusual responding represents a higher level of cognitive maturity than popular responding. The data on age trends of decreasing popular responding in the current study and increasing unusual responding in the earlier study support Feldman's contention. The developmental aspects of creative thinking are important questions to which future research might profitable be directed.

Methodological suggestions for future studies

We surveyed the three reviews of problem-solving tasks (Davis, 1973; Ray, 1955; Speedie, Treffinger, & Houtz, 1976) and found that stringent tasks with more than one correct solution that are appropriate for children

are few in number. There were not enough stringent items in the current study, and we therefore obtained a narrow range of scores. In future studies we will develop a much larger number of stringent tasks. They will be of two types, one type for general use across age, intelligence level, and SES groups, and another type for use with a particular group.

In the current study there were as many as six independent variables (age, sex, intelligence level, SES, creativity level, and reinforcement). It was impossible, given 142 subjects, to do an all-inclusive analysis. In future studies we plan to use enough subjects to permit overall analyses. Replication with more subjects will confirm trends that were obtained and may yield addiitonal findings on individual differences.

Reinforcement failed to increase original responding in the current study. Nevertheless, it is premature to conclude that verbal reinforcement is ineffective for this purpose. In future studies we will utilize more stringent tasks and will administer the lenient and the stringent tasks on separate occasions. Verbal reinforcements are routinely dispensed by parents and teachers in their interactions with children. It is, therefore, important to understand the consequences of these reinforcements for children of each age, sex, intelligence level, and SES and to plan programs in school that match the reinforcement patterns of the pupils.

In the current study we did not maintain the distinction between unusual responses of high and of low quality. The reasons for this decision were explained above in detail. Upon reflection, utilizing the total unusual score seems not only justifiable but even desirable. The process of judging

unusual ideas of high and low quality is strongly influenced by the social and cultural milieu of the judges. An idea that may seem inappropriate at one time and place in history may be seen as a highly original useful idea at another. Consider, in this context, the ridicule heaped upon many creative geniuses because they presented ideas whose time had not come. By considering all unusual responses as the index of quality responding, we avoid the pitfall of excluding some original ideas that might be considered inappropriate and of low quality by the standards of the judges.

tringent solution-standard laboratory tasks have been regarded in this report as criterion measures. This is justified when the stringent measures are viewed in relationship to the lenient measures. On the other hand, we should remember that all of these measures are laboratory tasks and not real-world creative behaviors. Since real-world creative behaviors are certainly more similar to the stringent than to the lenient tasks, the current study represents a step in the right direction. Notwithstanding the difficulties, we must search for ways to use real-world behaviors as criterion measures in studies on original problem-solving.

Educational implications of the findings

A major goal of research on the creative process is to identify people who are able to produce original solutions to difficult life problems. This ability is operationally defined as the unusual score on the stringent measure. We found that the score for total number of responses both to lenient and stringent tasks were both excellent predictors of the unusual score on the stringent measure. Total scores are easily obtained by simply counting discrete responses and are, therefore, an economical and efficient method of assessing original problem-solving ability.

There has been a widespread misinterpretation in the educational community of the role of ideational fluency : regarding it as a criterion rather than as a predictor . This misinterpretation has led to a number of negative educational practices. Creativity starts with the free expression of ideas of all kinds, even ideas which are unusual and of low quality. This first stage in which many ideas are generated is essential but not sufficient. Not all ideas which are produced are valuable. Productive creative thinking involves not only suspending judgment and generating many ideas, but also invoking judgment in order to evaluate the ideas produced. Many educational programs, designed to enhance creative thinking, emphasize the first and ignore the second.

Future studies on creativity

The 1970 White House Conference on Children underlined the importance of creative ability in children of all ages and recommended that intensive efforts be made to develop creative teachers for the schools. The United States Office of Education now includes creative thinking among the abilities to be considered in selecting children for participation in federally supported programs for the gifted and talented. Moreover, a statutory mandate exists requiring the use of objective criteria in identifying gifted and creative children. It is, therefore, surprising that research in the last decade has produced no great advances in our understanding of the creative process and that we are still basically operating with information developed between 1950-1970 by Guilford, Mednick, Torrance, Wallach, Kogan, Getzels, and Jackson.

During the last decade there has been a dramatic increase in the interest of researchers in infancy and early childhood. One impetus for this heightened interest comes from the growing number of mothers of preschool children working outside the home and the desire of these families to understand the impact of day care centers on the intellectual and personal social development of very young children. Most studies of the intellectual functioning of preschool children have focused on problem-solving processes utilizing convergent thinking of intelligence. By contrast, few studies have examined creativity which utilized divergent thinking processes.

In future studies we plan to replicate the current study and to introduce modifications based upon the data reported above. We plan to extend our investigation of the creative process in the following directions: (1) We will conduct longitudinal and cross-cultural investigations of original problem-solving in children of preschool age and older, in black and white children, and in children of different countries; (2) We will examine six cognitive capacities (ideational fluency, curiosity or preference for novelty, fantasy, imagination, metphoric production, selective attention deployment) and determine the relative contribution of each in explaining individual differences in original problem-solving; (3) We will develop criterion measures of real-life creative behaviors in a variety of areas and examine their relationship to each other and to each of the component predictor capacities mentioned above; (4) We will examine parental influences on the development of creative abilities in children. The influence of two aspects of child-rearing will be considered: (a) the model of creative thinking and creative behavior provided by parents; and (b) the space available for child's unimpeded independent activity in the home.

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